MEMORANDUM REPORT ARLCB-MR-79011

GUN TUBE MANUFACTURE BY AUTOMATION

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June 1979

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
LARGE CALIBER WEAPON SYSTEMS LABORATORY
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WATERVLIET, N. Y. 12189

AMCMS No. 3297.06.7242

DA Project No. 6737242

PRON No. M1-3-23022-M7-M7

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARLCB-MR-79011
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:
4. TITLE *(and Subtitle)*: GUN TUBE MANUFACTURE BY AUTOMATION
5. TYPE OF REPORT & PERIOD COVERED:
6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): C. LaRoss
8. CONTRACT OR GRANT NUMBER(s):
9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Benet Weapons Laboratory
Watervliet Arsenal, Watervliet, N.Y. 12189
DRDAR-LCB-TL
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
AMCMS No. 3297.06.7242
DA Project No. 6737242
PRON No. M1-3-23022-M7-M7
11. CONTROLLING OFFICE NAME AND ADDRESS:
US Army Armament Research and Development Command
Large Caliber Weapon Systems Laboratory
Dover, New Jersey 07801
12. REPORT DATE: June 1979
13. NUMBER OF PAGES: 24
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*:
15. SECURITY CLASS. *(of this report)*: UNCLASSIFIED
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:
16. DISTRIBUTION STATEMENT *(of this Report)*:
Approved for public release; distribution unlimited.
17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*:
18. SUPPLEMENTARY NOTES:
Originally submitted as an MM&T report to the US Army Armament Materiel Readiness Command on 6 January 1978.
19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*:
Line Flow
Tube Face Milling
Hollow Spindle Loading
20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*:

This report describes three areas of the production line in manufacture of gun tubes that, with improvement, would be beneficial to gun tube manufacture by automation. The purpose of the project was to highlight and improve these areas to result in an improved gun tube manufacturing facility.

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DRDAR-LCB-SE

Project No: 6737242

Project Title: MM&T: Gun Tube Manufacture by Automation

Statement of the Problem: In the process of manufacturing gun tubes there are machining operations that are more difficult to perform than others and therefore are more costly to produce on a production line basis. Machine placement in a production line also seriously affects the time a component will be in a move status. Added time in this area is inefficient and an obvious increase to product cost. And thirdly there are loading and unloading operations in the manufacturing cycle that, if improved upon, would be of great benefit. These three areas represented the direction in which the efforts of this project would be directed.

Initial efforts were applied to a plant layout and proposed flow of components for improving the manufacture of the 105mm M68 and 155mm M185 gun tubes. This was pursued because it presented a fresh look at current manufacturing techniques and as a result highlighted areas where improvement was most needed. After this effort was accomplished the second phase concentrated on areas of machining difficulty, and loading and unloading problem areas. In searching for an area of manufacture which presented machining difficulty and resulting high manufacturing costs, the breech face detail was outstanding and efforts were concentrated there. In the area of handling for loading and unloading of 105mm M68 gun tubes the investigation uncovered two areas of greatest handling difficulty, one of which was considered more of a problem than the other and therefore efforts were concentrated to easing this problem.

Because this project was conducted in three distinct phases, the discussion is also divided into three phases, each of which is considered separately.

This project was accomplished as part of the US Army Manufacturing Technology program. The primary objective of this program is to develop, on a timely basis, manufacturing processes, techniques and equipment for use in production of Army materiel.

I - Sequence of Operations (Flow)

Background and Introduction

For optimum results in the manufacture of any component the production cycle should flow harmoniously from the initial operation of manufacture to the last. All related functions other than machining operations should be inserted in the manufacturing cycle to allow the even flow of the component part from start to completion. Evaluation of the methods currently being employed revealed some deviations from what would be considered a smooth flow process.

What was required was an evaluation of the current process of manufacture, followed by a consolidation and/or rearrangement of manufacturing processes to arrive at the optimum method of manufacture for the 105mm M68 and 155mm M185 gun tubes, including recent process improvements.

Approach to the Problem

The evaluation involved the review of route sheets for operational sequence and on site investigation of the manufacturing cycles of both gun tubes. These examinations revealed areas where there was need for improvement. It also uncovered areas where there was potential for complete change of the manufacturing process and possibilities for combining operations to effect cost savings. Upon completion of these evaluations a routing was drawn of a proposed manufacturing process and forwarded to Operations Directorate, Industrial Engineering Branch for concurrence. Assistance was requested from Plant Layout Unit in developing a floor plan utilizing the proposed manufacturing process developed. It was requested that Plant Layout exercise its expertise coupled with the assumption that the most suitable manufacturing areas were available. The reason for the suggested assumption was to allow maximum range of imagination and ingenuity. This combination of effort then would yield the guidelines for an optimized line.

Discussion of Results

As a result of the combined efforts a new proposed manufacturing sequence was developed and a plant layout of that development was prepared. Incorporated into it were the past proven MM&T techniques advanced by the Machine Process Activity, Benet Weapons Lab and developments of the Production Methods Section, Arsenal Operations Directorate. Also incorporated into this proposal were the areas of the manufacturing cycle that were found to be most troublesome in machining. In addition, the areas that presented difficulty in handling for loading and unloading of gun tubes were also incorporated.

Conclusions

The improved sequence of operations which was developed for the manufacturing facilities of the 105mm M68 and 155mm M185 gun tubes in Bldg. 35 was completed. The improved manufacturing process of the 105mm M185 cannon tubes was implemented during the reorganized layout of IPE in the Medium Caliber Gun Ship, Bldg. #35

II - Machining Breech Face Detail

Background and Introduction

The machining of the breech face detail on the 105mm M68 gun tube is a complex machining operation. Various attempts at reducing the cost of this operation have met with unfavorable results. Earlier attempts such as electro chemical machining and profile duplication methods (Keller MOD-C) have not alleviated the problem. These methods were not consistently reliable and therefore not dependable for production line use. These attempts at improving the machining of this problem operation, although unsuccessful, were helpful in establishing guidelines in which further attempts would be directed.

Approach to the Problem

Machining of the breech face detail (see WTV-D-25283 Figure 1) on the 105mm M68 gun tubes, as it is currently being performed, is set up in horizontal boring mills. This involves the blending in of five (5) difficult milling cuts (Figure 2) by the operator to tolerances of plus two thousandths of an inch (.002"). The operator is also required to move or roll the gun tube twice to position and align angular cuts across the breech face of the gun tube. The time allotted to perform this operation is 4.54 hours. All of these requirements represent a time consuming and difficult machining operation not to mention a tedious and unnecessary customized operation.

Discussion of Results

A series of tests were performed to demonstrate a superior method of machining the breech face configuration. Two (2) stub tube blanks were prepared as per Dwg. WTV-C25284 Figure 3 for experimental machining, utilizing numerically controlled equipment to meet drawing requirement WTV-D25283 (Figure 1.) Through Production Planning and Control Branch a program was prepared for the tests. The machine selected was a Cincinnati Cim-X-Changer WV-11308, see Figure 4, located in Bldg. 20. A series of eight (8) machining tests were conducted. All of the eight (8) machined ends were inspected by Quality Control Branch Bldg. 20; the results were encouraging (Table 1). The conclusions reached

after all test reports were evaluated, were that this process of manufacture by numerical control be adopted by the Arsenal Operations Directorate as soon as possible as it represented a cost savings of approximately 60 per cent over the method currently employed.

The improved process would afford the following advantages over the current method.

a. Reduction of set-up and machining time of 60 percent.
b. Eliminate a bottleneck in the production line.
c. More uniformly controlled product.
d. Utilization of automatic equipment applied to a tedious machining operation eliminating operator fatigue and error.
e. Improved process of manufacture.

Conclusions

The actual machining tests, accomplished through this MM&T project effort, emphasized the necessity to machine the breech face detail on the 105mm M68 gun tubes by N/C equipment. As a result of these machining tests a cost savings of approximately 60 percent will be realized over the method presently employed. Two Breech End Detail Machines are being acquired under the 75 PSR, project #6756957.

III - Hollow Spindle Loading Device

Background and Introduction

In the area of handling gun tubes in the process of loading and unloading the machine tool, two operations stood out as problem areas and were evaluated accordingly. The two areas of difficulty in loading and unloading were powder chamber grinders and hollow spindle lathes. The powder chamber grinders were selected for improvement as they represented one of the more costly operations performed in the manufacture of the 105mm M68 gun tube. Previous to this project effort, there were no attempts to reduce the cost of powder chamber grinding in regards to loading and unloading the machine.

The present practice requires the operator to guide the gun tube (which is suspended from an overhead crane) into and through the machine spindle to a preset position for location. This method results in the gun tube banging into some part of the machine (usually the chuck jaws) or the location stop. As a result, some damage occurs simply because the gun tube weighs approximately 2000 lbs at this point of manufacture. In addition, the process does not locate the gun tube accurately in a longitudinal position for the grinding operation. It is necessary for

the operator to position the gun tube by jarring it into location with a large soft faced hammer. The process developed eliminated this condition.

Approach to the Problem

The following steps were taken in developing a new and improved process for powder chamber loading and unloading. Several concepts were analyzed and evaluated as to costs and adaptability to the present method of manufacture. One was chosen as best adaptable and design services was requested to provide assistance in designing and drafting the concept. This design was completed and approved and is detailed on Dwgs. WTV-F26275 Tube Loading Assembly Fig. 5 & 6, WTV-F26276 Bed(Fig. 7)and WTV-F26277 Carriage (Fig. 8 and 9).

Discussion of Results

The loading device has been installed on WV 2982 Figure 10. The operational sequence is described in detail in Table 2. The process simply requires that overhead crane service load the gun tube onto the carriage of the tube loading assembly WTV-F26275 (See Figure 10 & 11). The crane is then released to provide service to other areas of the manufacturing line. The operator then secures the gun tube in the carriage and by push button control, positions the gun tube into the powder chamber grinder in a matter of seconds. Because the gun tube is secure in the tube loading assembly and aligned to the machine spindle the danger of banging the gun tube into the machine and causing damage is eliminated. The advantages of this process are:

(1) More efficient loading and unloading.
(2) Elimination of damage in loading and unloading.
(3) Accurate positioning.
(4) Quick release of the crane for other servicing.
(5) Safer method of loading and unloading.

The hollow spindle loading device provides a safe and efficient method of loading hollow spindle equipment. The process should be adapted to all powder chamber grinders. The time savings is approximately 6 minutes per tube.

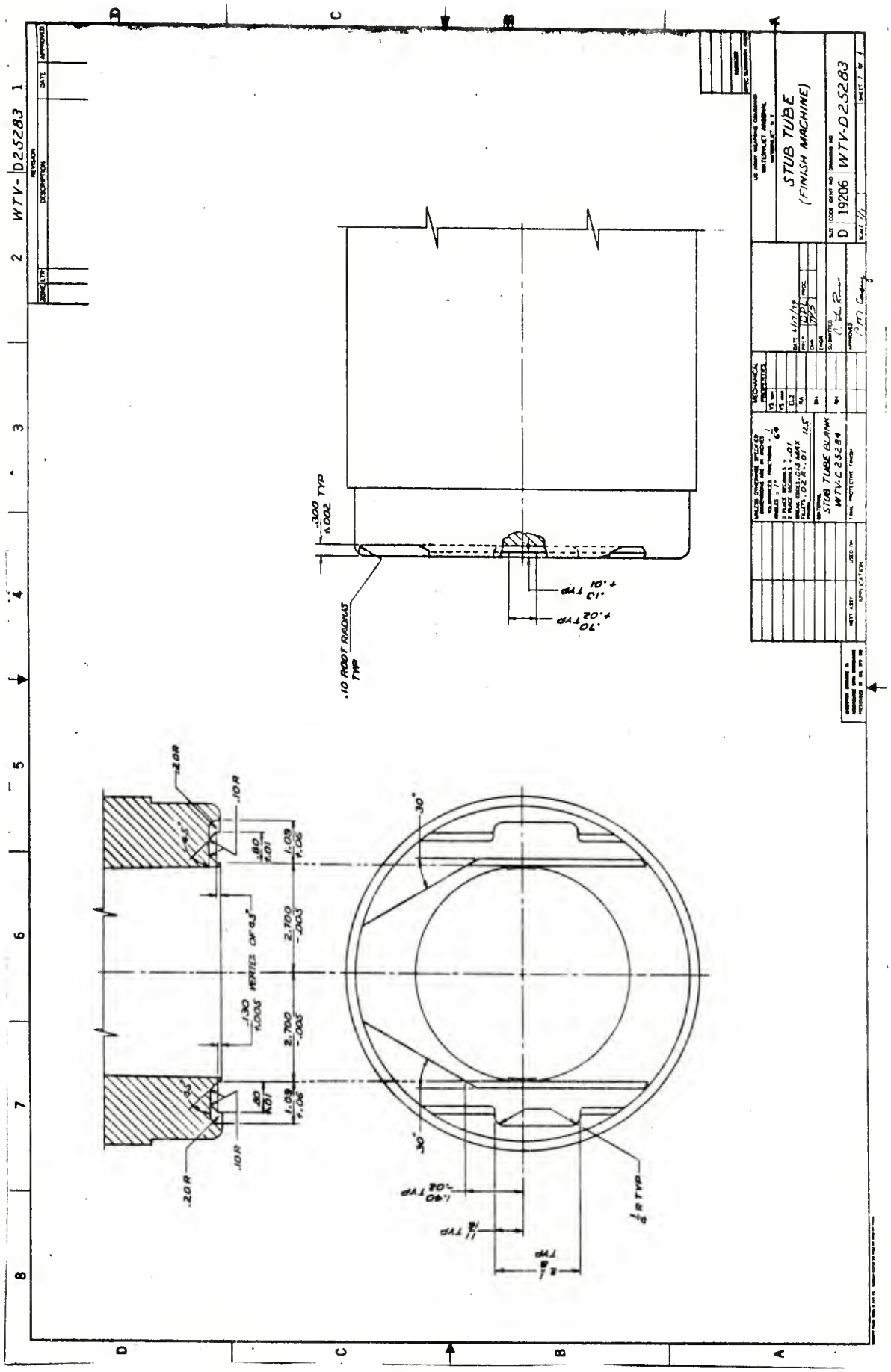
STUB TUBE
(FINISH MACHINE)
WTV-D25283
.10 ROOT RADIUS TYP
.20R
.10R
30°
VERTEX OF 45°

Figure 1

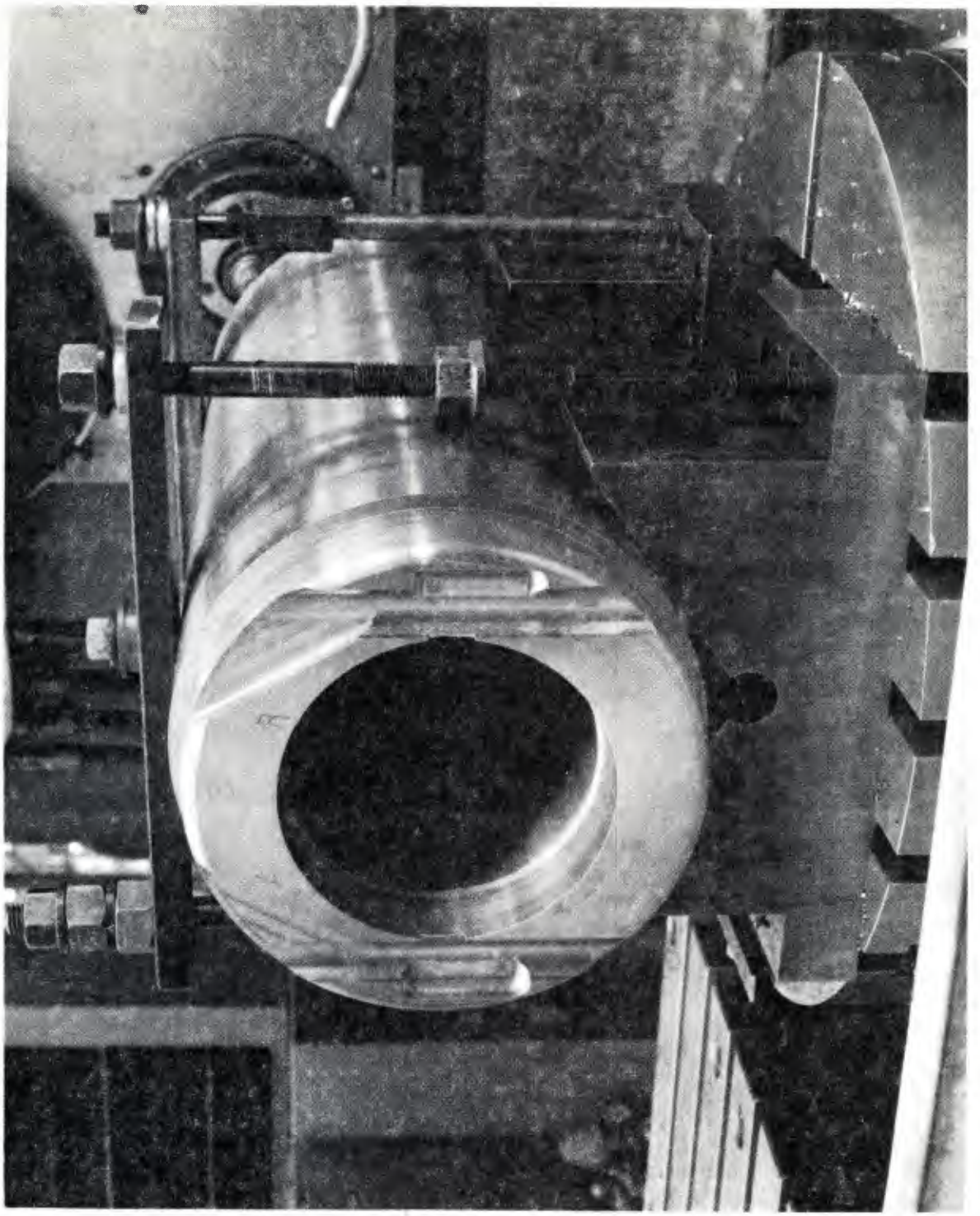

Figure 2. End view of breech face extractor detail machined by N/C equipment

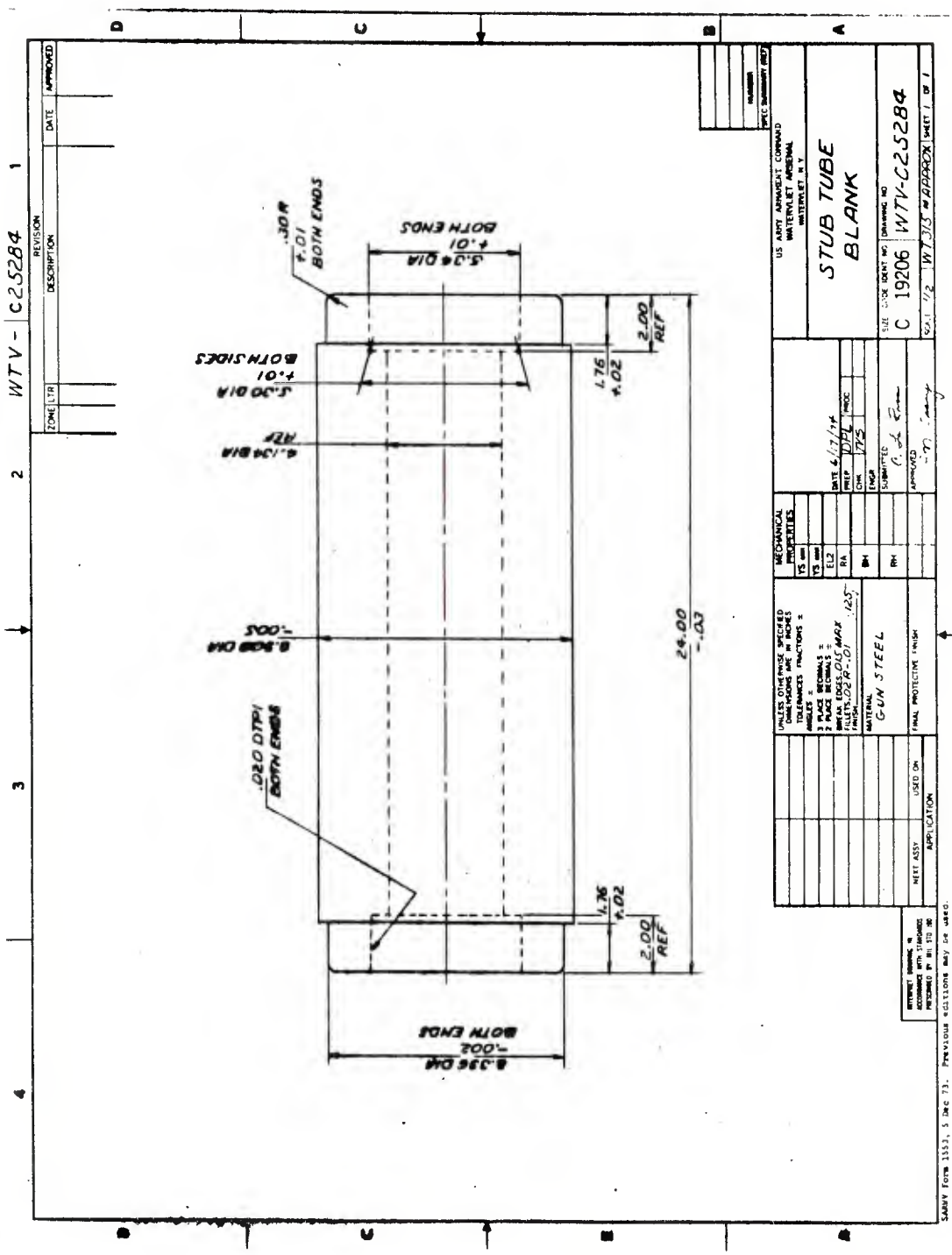
WTV - C25284
STUB TUBE
BLANK
WTV-C25284
C 19206
GUN STEEL
24.00 -.03
2.00 REF
4.76 +.02
.020 DTPI BOTH ENDS
BOTH ENDS
BOTH SIDES
.125

Figure 3

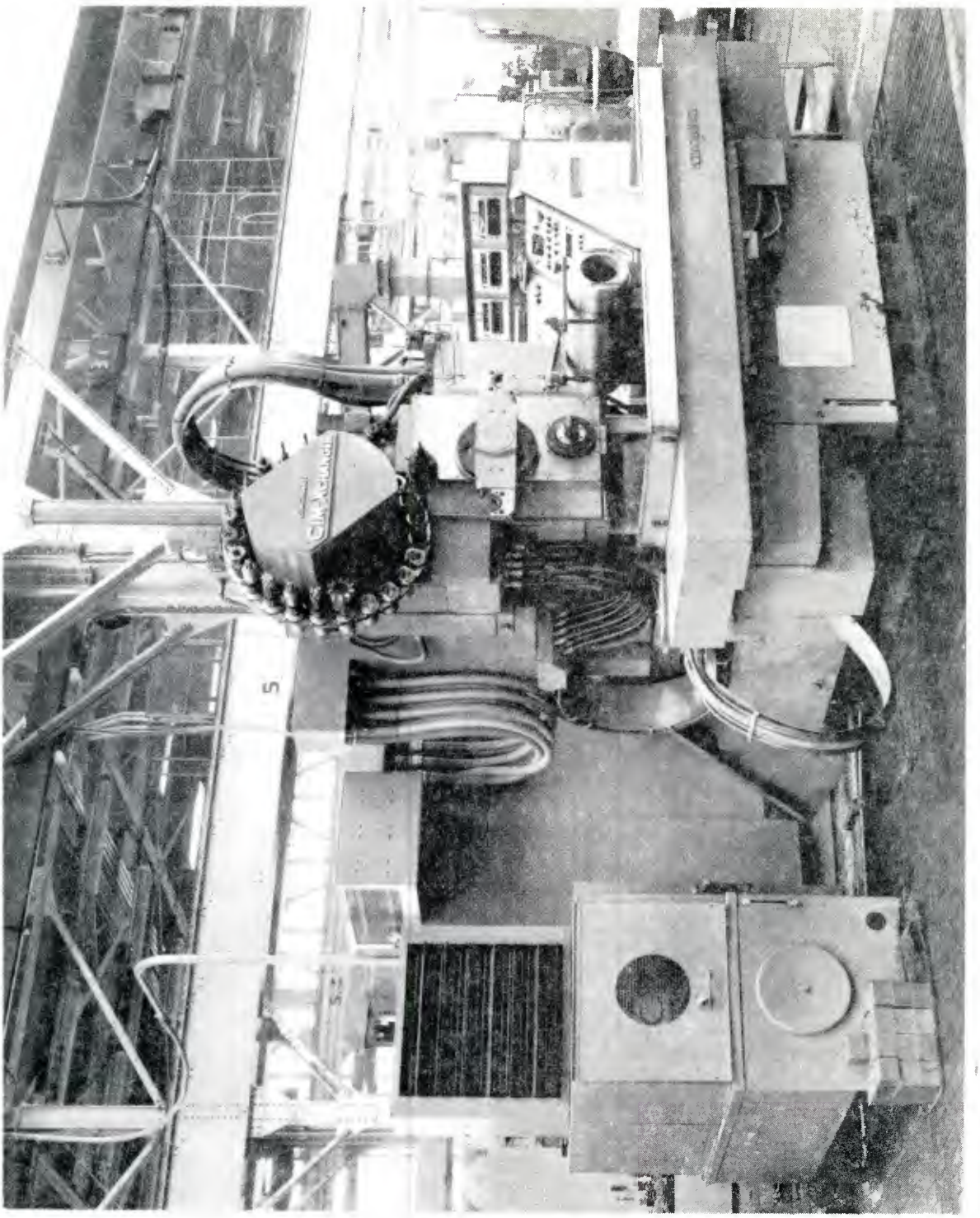

Figure 4. N/C machine set up for experimental machining of extractor detail on 105mm M68 Stub Tube

TABLE I

N/C MACHINING BREECH DETAIL

COST COMPARISON

PRESENT METHOD BLDG. 35 WV 3796 WV 7751			N/C MACHINING BLDG. 20 WV 11308			SAVINGS PER TUBE
FLOOR TO FLOOR	HRS.	1 JULY 74 COST AREA 1-0-1-1 $25.30/HR.	FLOOR TO FLOOR	HRS.	1 JULY 74 COST AREA 1-3-1 $24.69/HR.	
HORIZONTAL BORING MILL	4.54		CINCINNATI CIM-X-CHANGER	*1.83		
TIME STUDY	4.54	$114.86	*EST. TIME ARRIVED AT BY EVALUATION OF MACHINING TESTS & CONSULTATION WITH PP&C PERSONNEL	*1.83	$45.18	$69.68

NOTE - CURRENT PRODUCTION QUANTITIES X SAVINGS PER TUBE WOULD RESULT IN A FULL AMORTIZATION WRITE OFF OF CAPITAL EQUIPMENT IN APPROX. 1.3 YEARS.

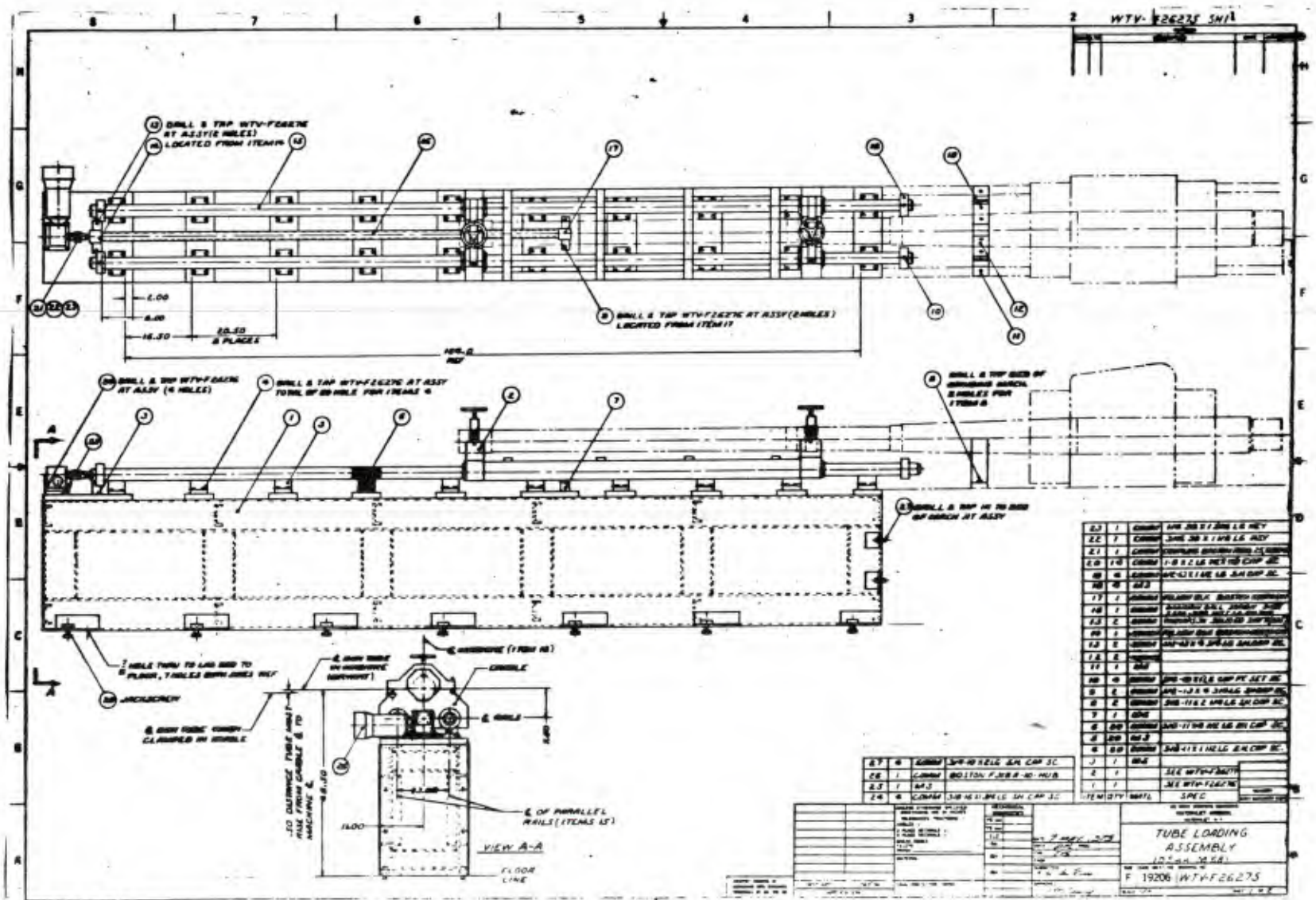
WTV-F26275 SH 1
VIEW A-A
TUBE LOADING ASSEMBLY
F 19206 WTVF26275

Figure 5

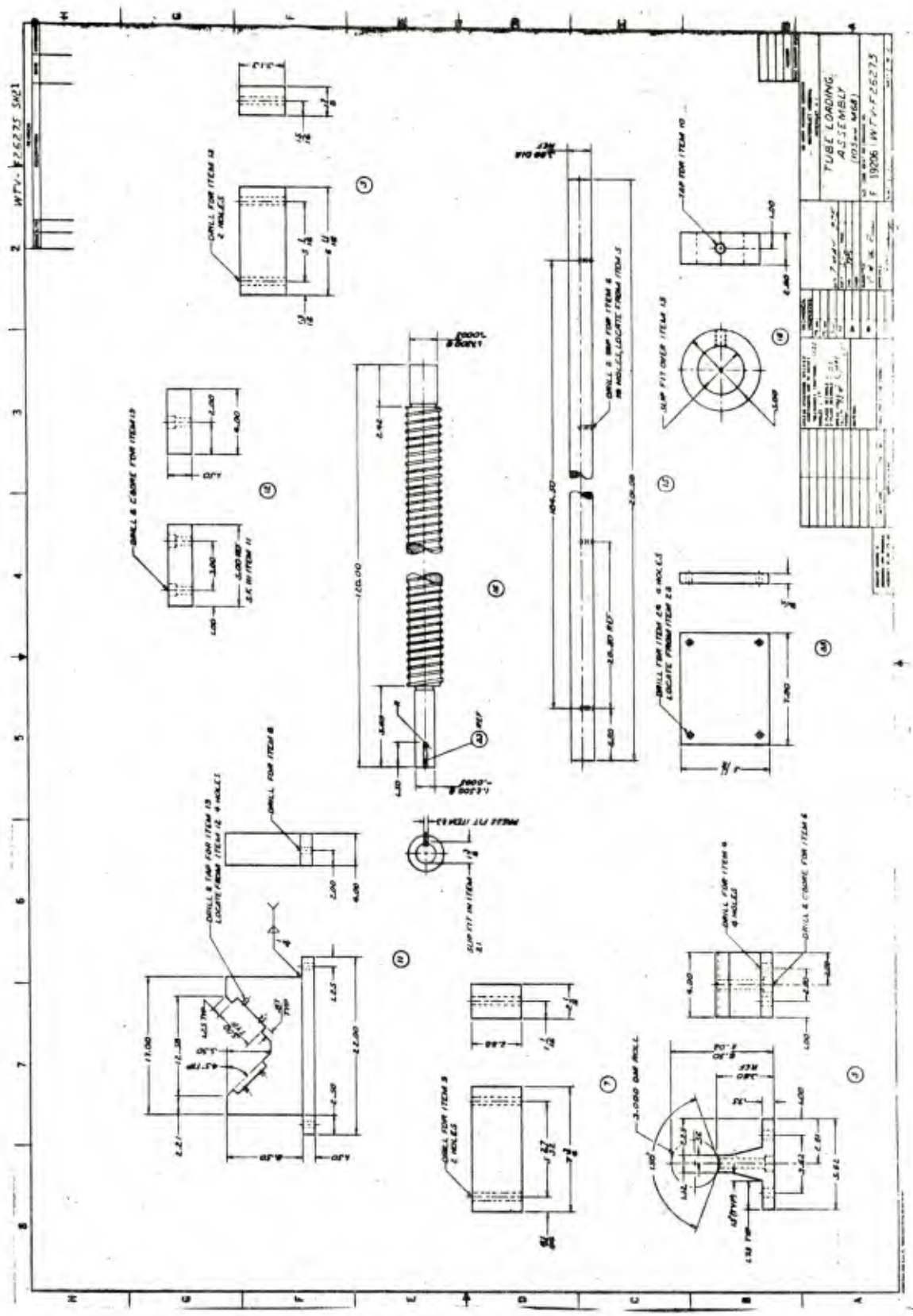

Figure 6

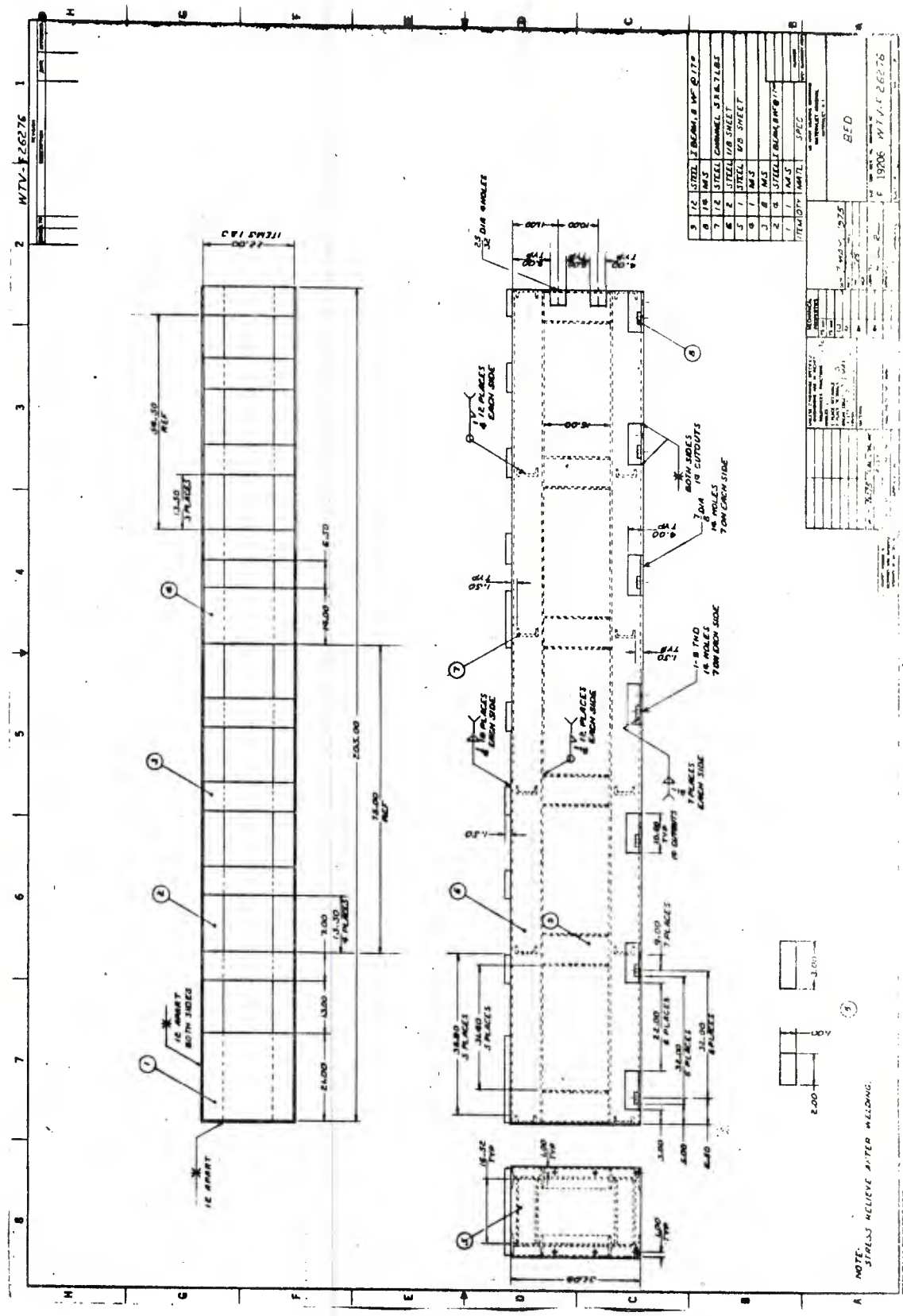

Figure 7

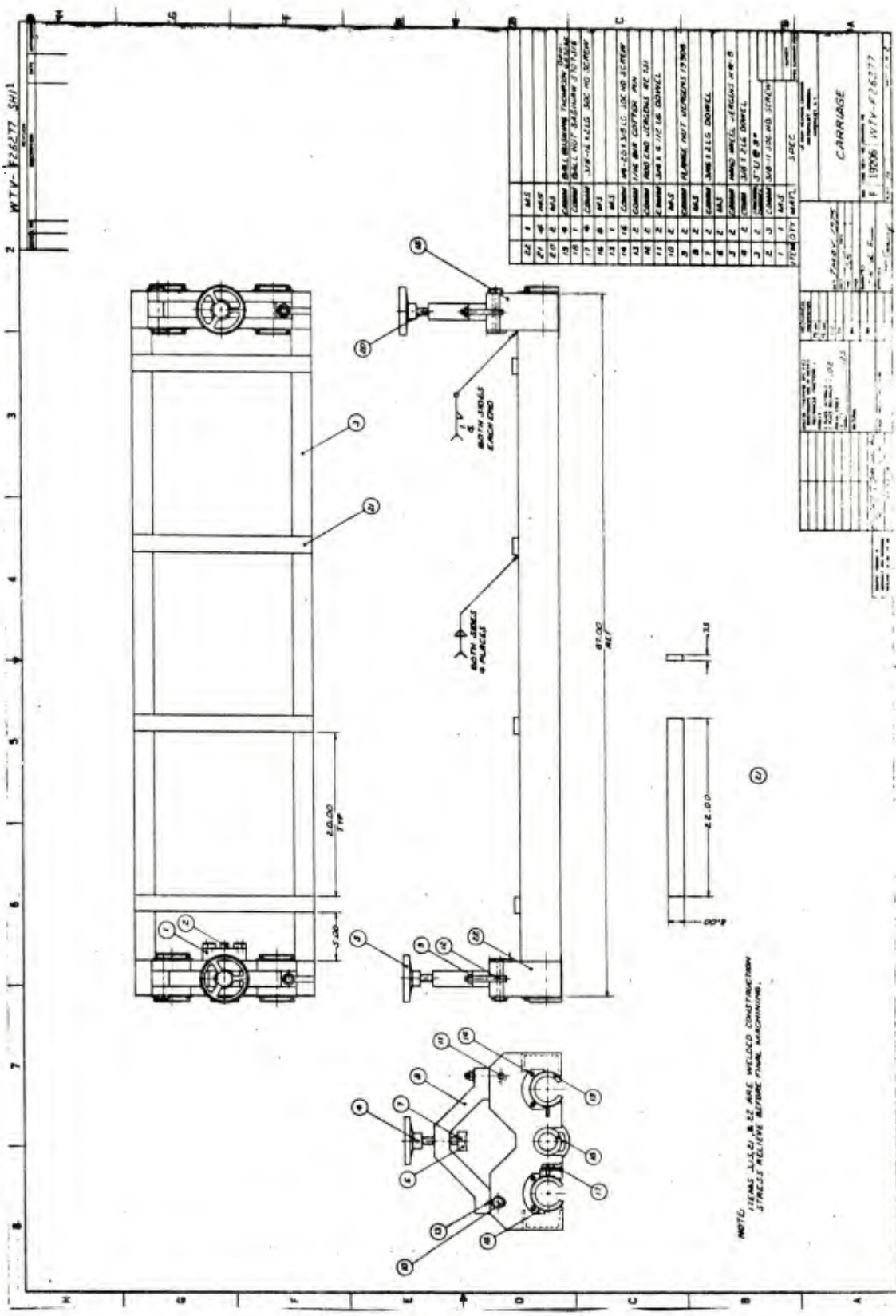
CARRIAGE
NOTE:
ITEMS 1,4,5, & 22 ARE WELDED CONSTRUCTION
STAKES NEEDED BEFORE FINAL MACHINING.

Figure 8

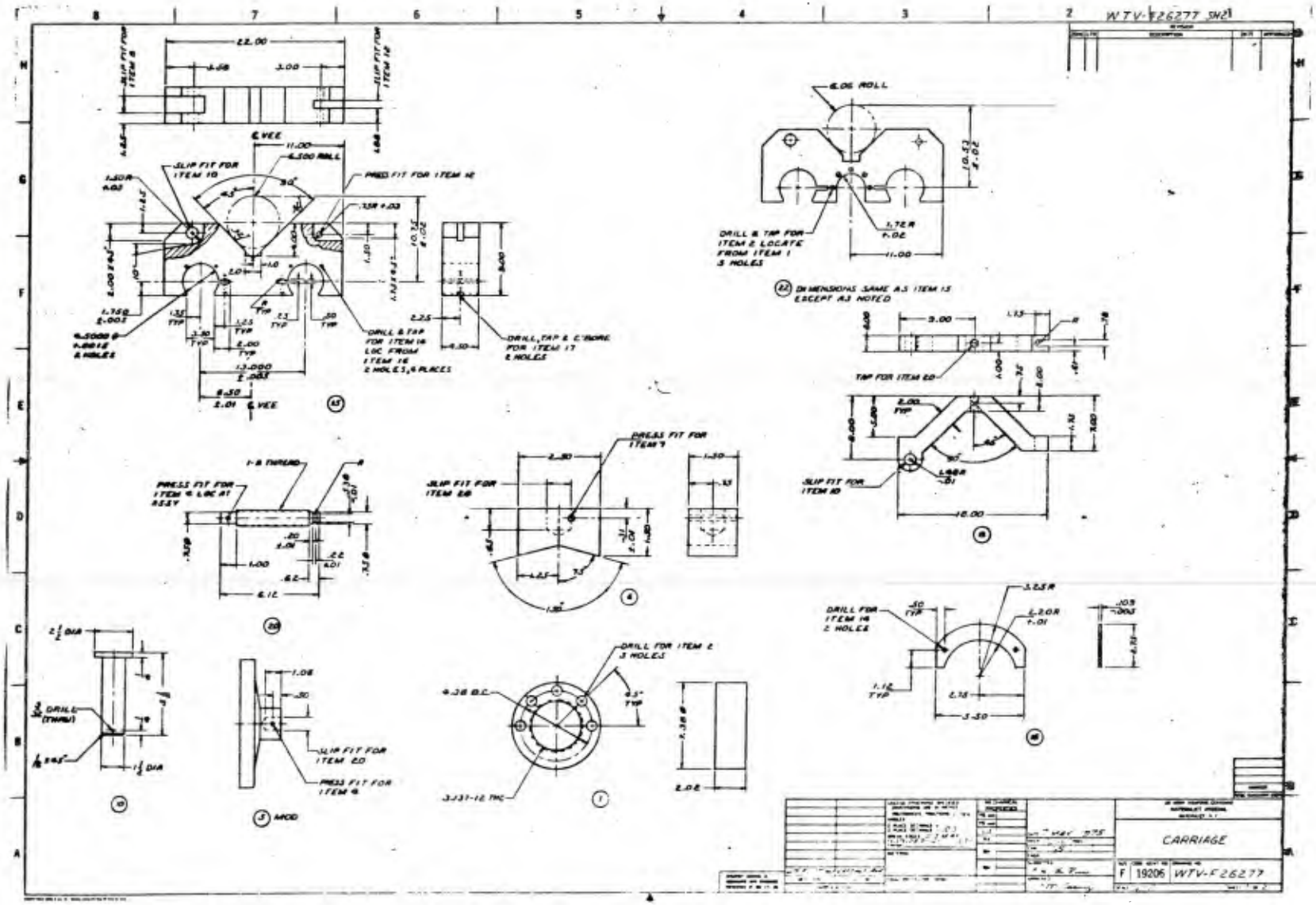

Figure 9

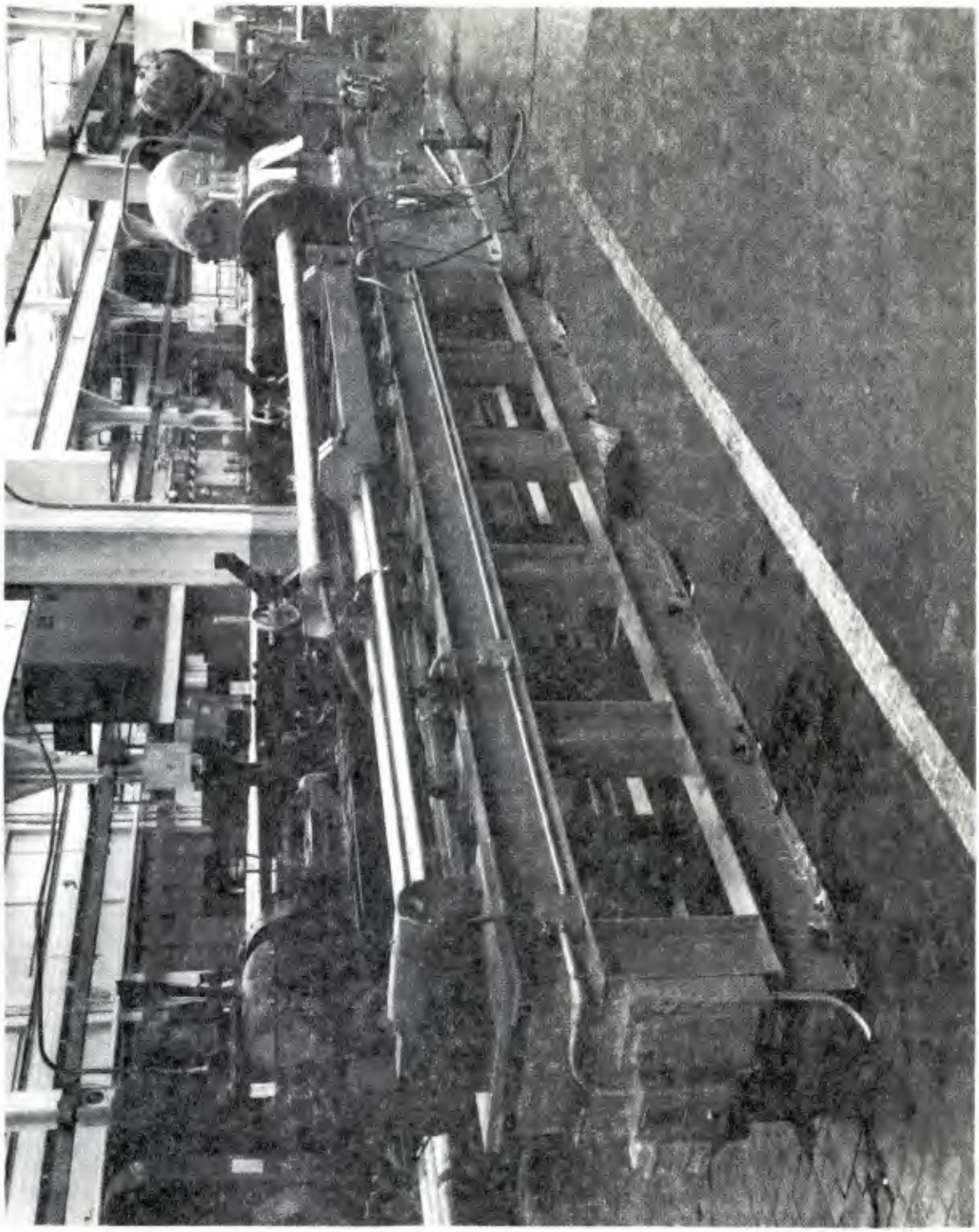

Figure 10. Tube loading assembly

Table 2

PROCEDURE FOR LOADING & UNLOADING POWDER CHAMBER LOADING DEVICE

1. Crane service loads gun tube into carriage with evacuator dia. located in middle "V" block.
2. Crane unhooks.
3. Operator closes clamp on rear "V" block & tightens clamp until breech end is lifted off forward "V" block.
4. Operator presses "FOR. JOG" button & runs gun tube into spindle of grinder stopping just short of set stop.
5. Operator "Inch" jogs breech face of gun tube up against set stop.
6. Operator releases rear "V" block clamp.
7. Operator checks for location.
8. When located, operator clamps gun tube in chuck jaws & checks for TIR.
9. Operator attaches coolant line to muzzle end.
10. Operator performs grinding operation.
11. Operator removes coolant line from muzzle end.
12. Operator releases chuck jaws.
13. Operator tightens rear "V" block clamp.
14. Operator presses "REV.JOG" button and removes gun tube from machine spindle.
15. Operator unclamps rear "V" block clamp & opens.
16. Crane service removes gun tube from carriage.

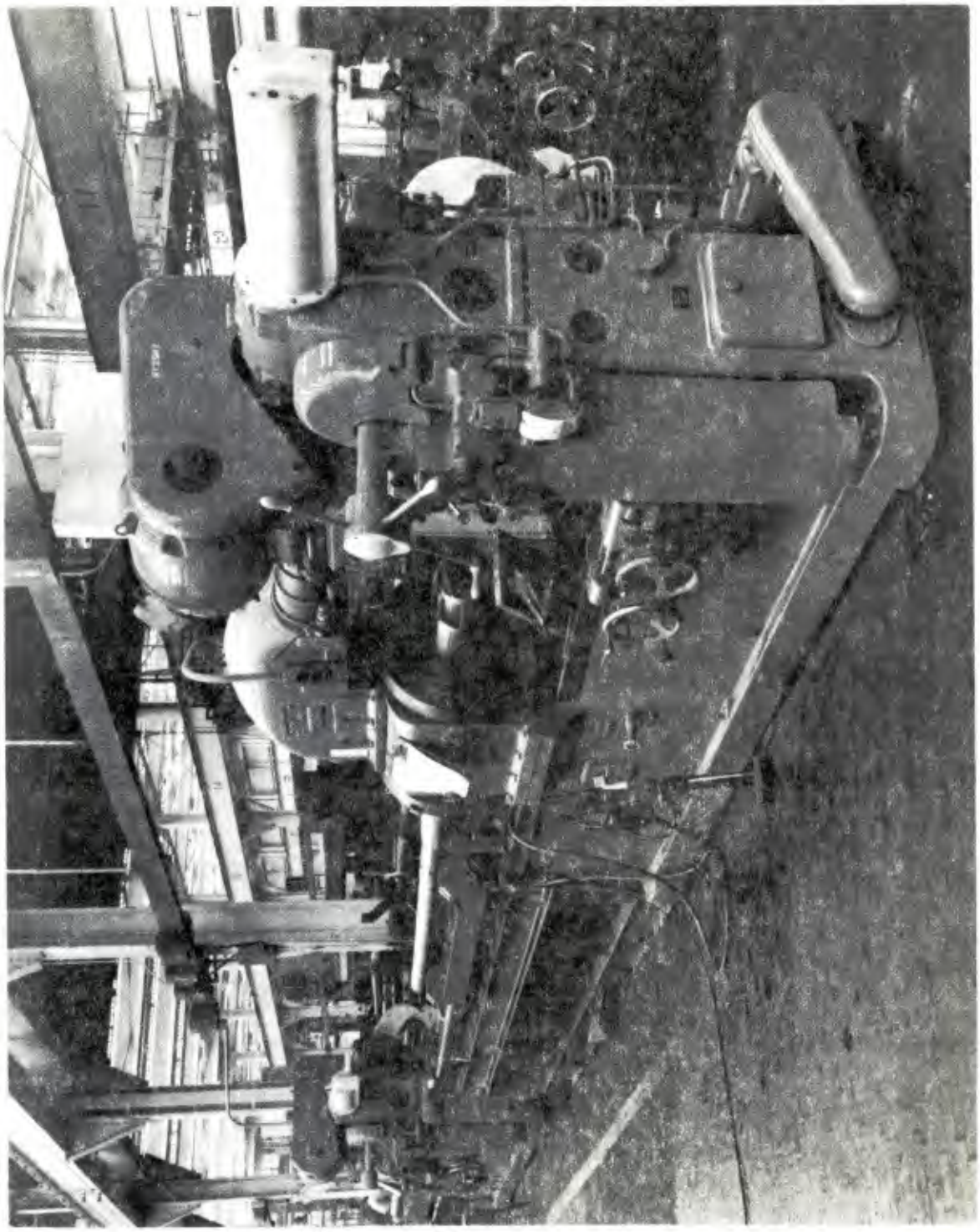

Figure 11. Tube loading assembly

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